

## **EXPERIMENT-5**

### **VOLTAGE SERIES FEEDBACK AMPLIFIER**

**AIM:** To design a Voltage Series Feedback Amplifier and to calculate the gain, feedback resistance, input resistance and to calculate the frequency response of Feedback Amplifier.

#### **APPARATUS REQUIRED:**

<b>S. No</b>	<b>Components</b>	<b>Specifications</b>	<b>Quantity</b>
1	Transistor(BC547) or (BC107)	$\beta = 150$	2
2	Resistors	20K $\Omega$ 7K $\Omega$ 1K $\Omega$ 3K $\Omega$ 2.2K $\Omega$	2 2 2 1 1
3	Capacitors	10 $\mu$ F 100 $\mu$ F 1 $\mu$ F	3 2 1
4	CRO	0-30MHz	1
5	Function Generator	Upto 3MHz	1
6	Bode Plotter		1

#### **THEORY:**

A Feedback amplifier is basically a type of gain adjusting amplifier. Based on the type of input and output(Whether it is current or voltage) there are 4 types of feedback amplifiers. In Feedback amplifiers, some part of the output signal is fed back to the input. Based on this we have a positive and negative feedback amplifiers. It is determined if the signal is mixed at the input in-phase or out-of-phase. Negative feedback is mostly used since the distortion produced at the output is less compared to positive feedback.

The circuit which will feed the output signal back to input is called as feedback network or also known as ' $\beta$ ' network. The value of the  $\beta$  network determines the gain of the overall circuit.

## **DESIGN SPECIFICATIONS:**

$V_{CC} = 12V$ ,  $V_{CE} = 6V$ ,  $I_C = 2-3mA$

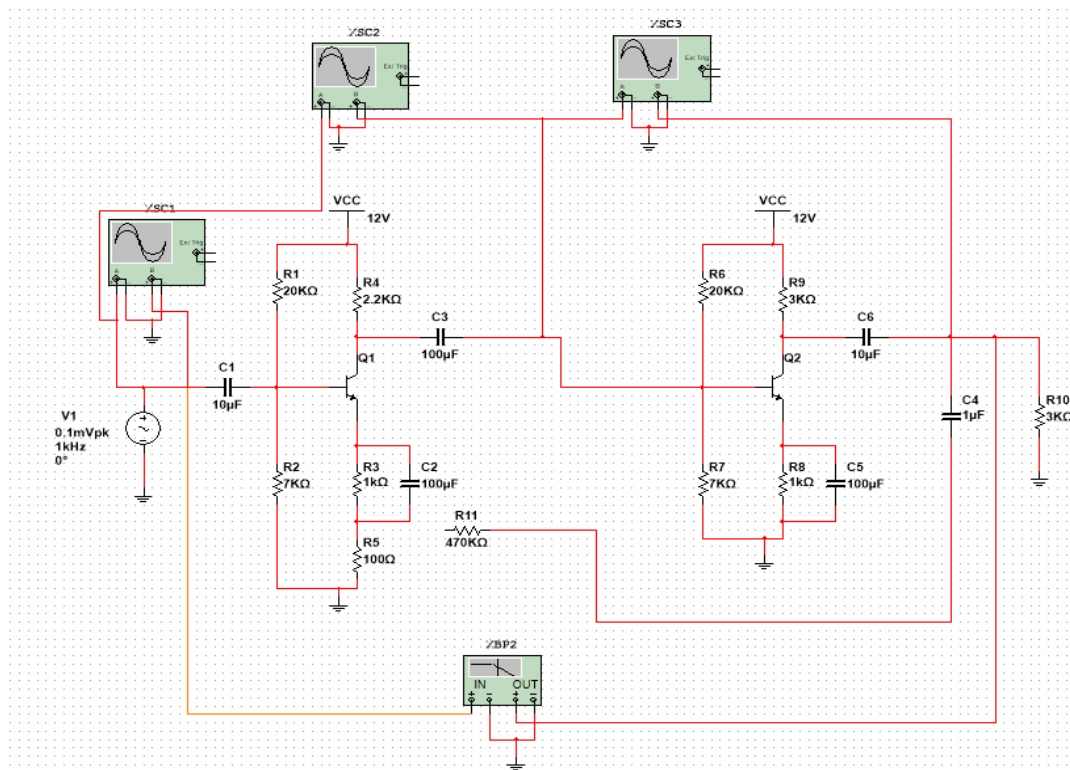
NPN transistor with ideal  $\beta = 150$ .

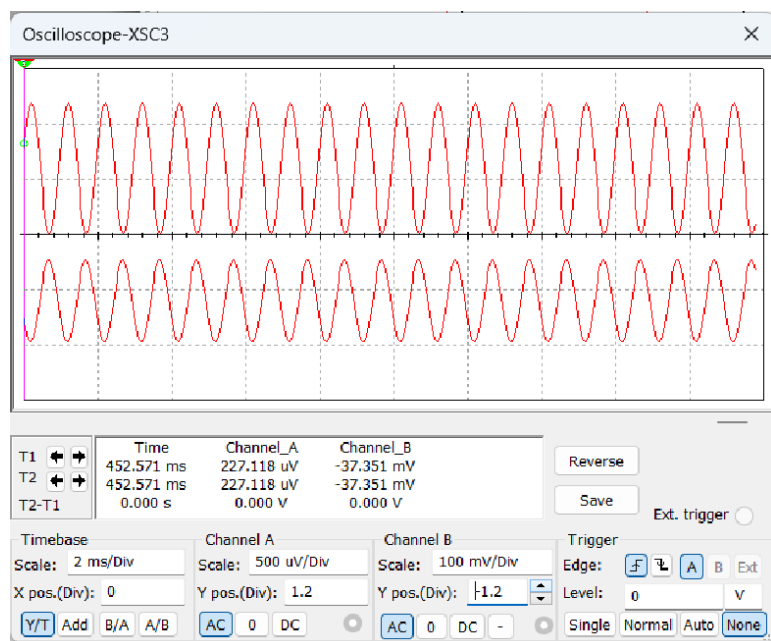
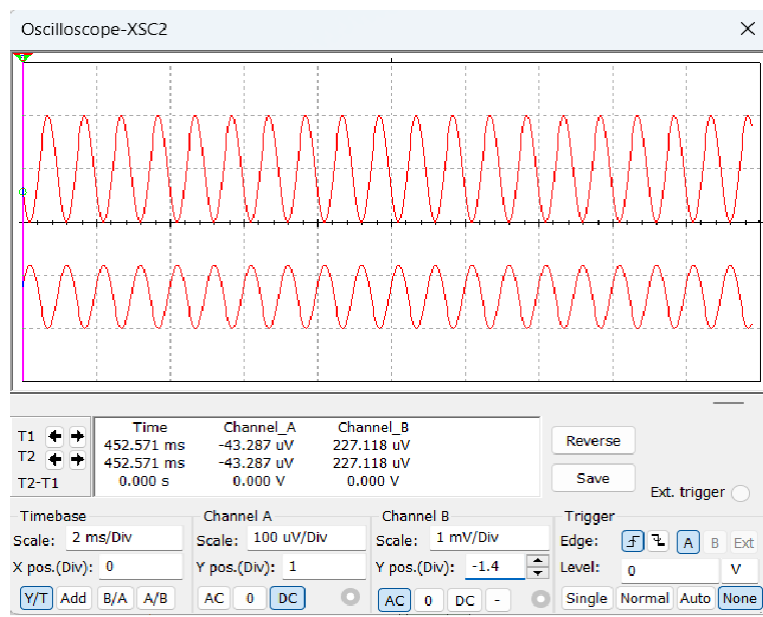
## **PROCEDURE (SOFTWARE):**

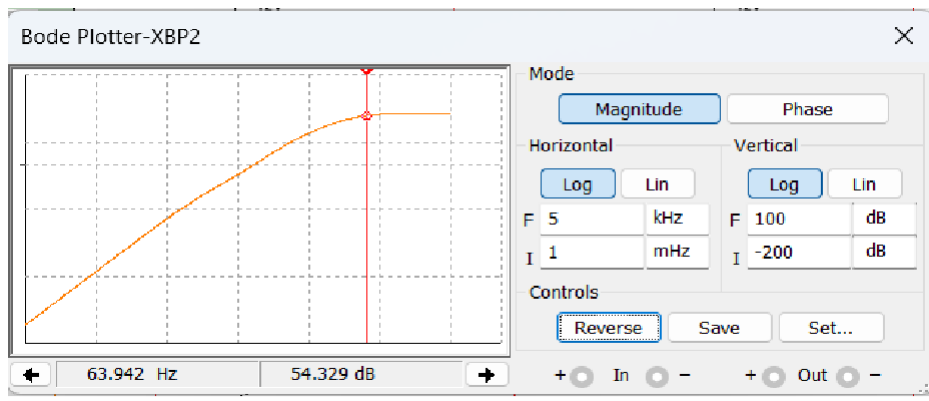
1. Open the Multisim software.
2. From the components toolbox bring the components required onto the workspace.
3. Connect the circuit components using wires.
4. Next adjust the values of the components as required.
5. From the Instrument toolbox bring the Oscilloscope and Connect one channel of the Oscilloscope to the input and another channel to the output for the first stage.
6. And to the another oscilloscope connect the output of first stage to one input and connect the output of the second stage to another channel.
7. Keep the Simulation in Interactive mode and run the design.
8. Observe the output and input waveform.

## **OBSERVATIONS:**

### **CASE-1:** Without feedback







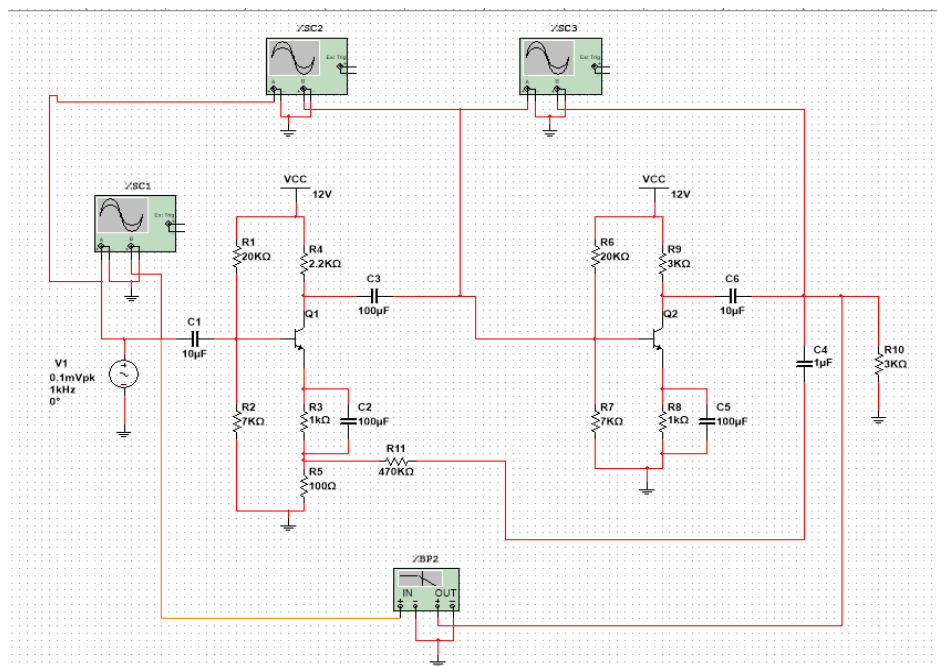
When there is no feedback, the amplifier is working as multistage amplifier. Cutoff frequency is at 54dB and the cutoff frequency of 64Hz.

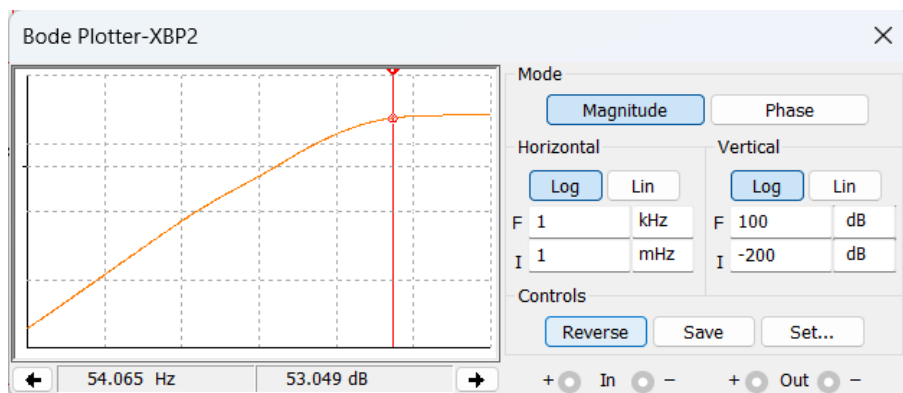
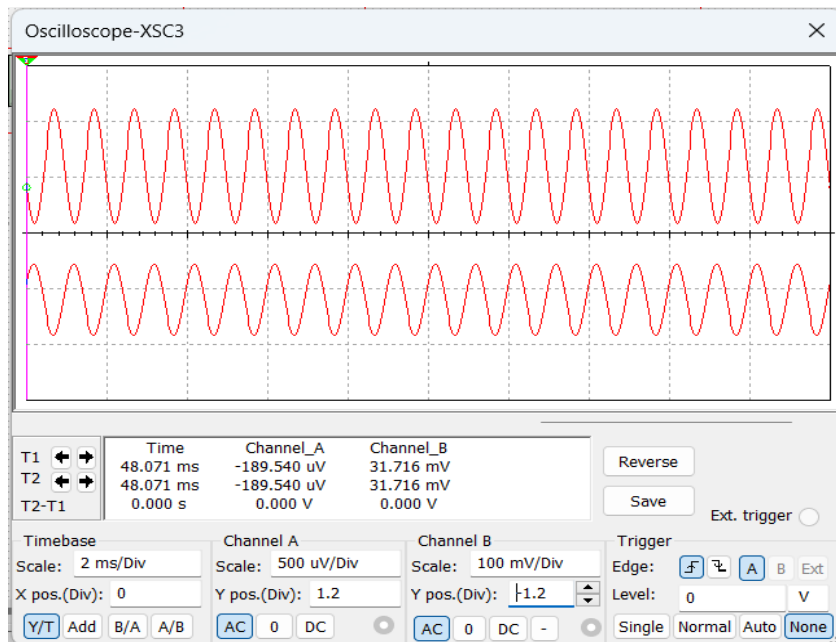
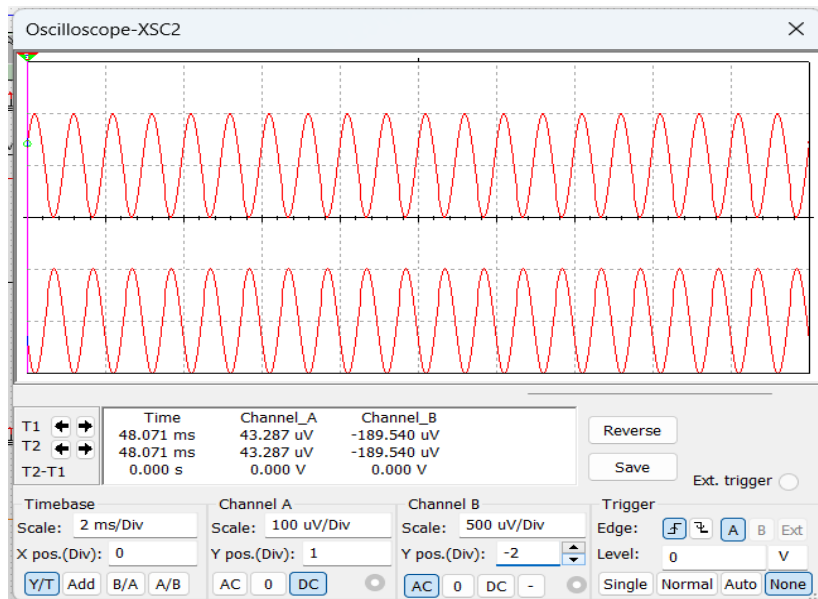
Gain of first stage of amplifier is  $(A_1) = 6$

Gain of second stage of amplifier is  $(A_2) = 125$

Overall gain of the circuit is  $(A) = A_1 \cdot A_2 = 750$ .

## **CASE-2:** With Feedback resistance of 470K $\Omega$





In the case of Feedback resistance at 470K $\Omega$ , the output almost seems to be equal to the output of the amplifier without feedback. This is due to high feedback resistance.

Due to high feedback resistance, maximum voltage gets dropped across the resistor and the signal does not get mixed at the input.

In this circuit, the mid frequency gain is obtained at 56dB. So, the cutoff frequency is at 53dB i.e., 54Hz.

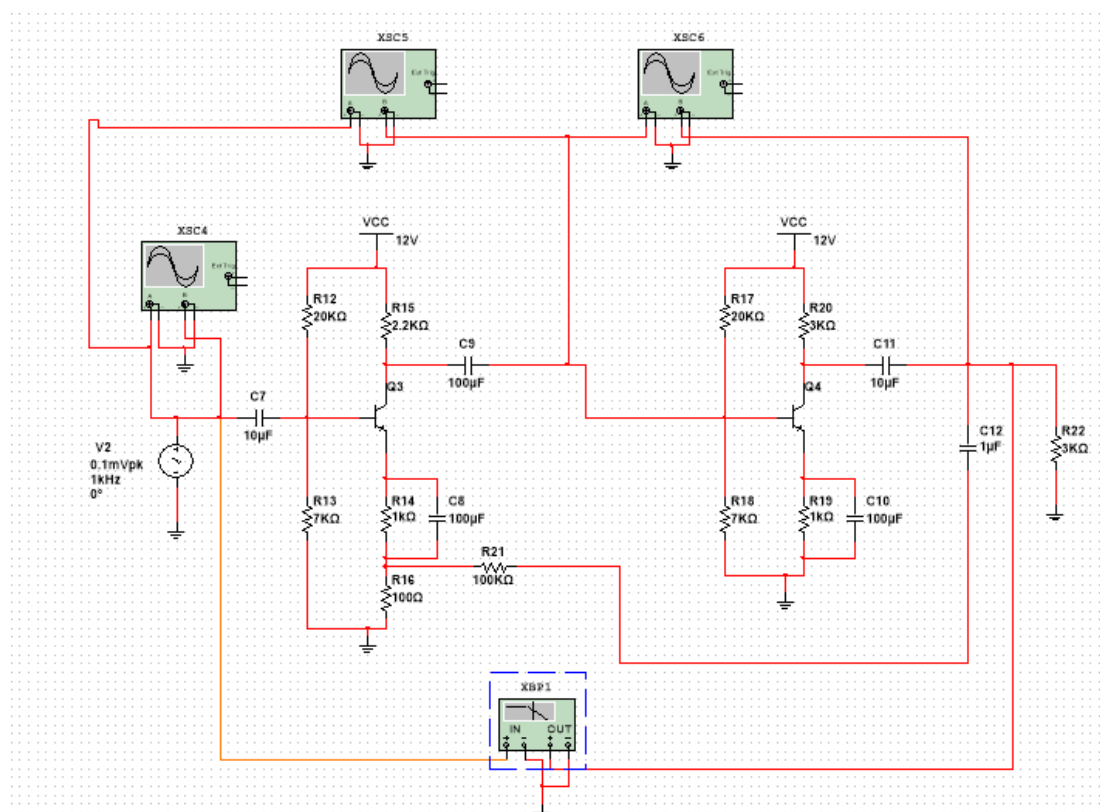
Gain of First stage (A<sub>1</sub>) = 5

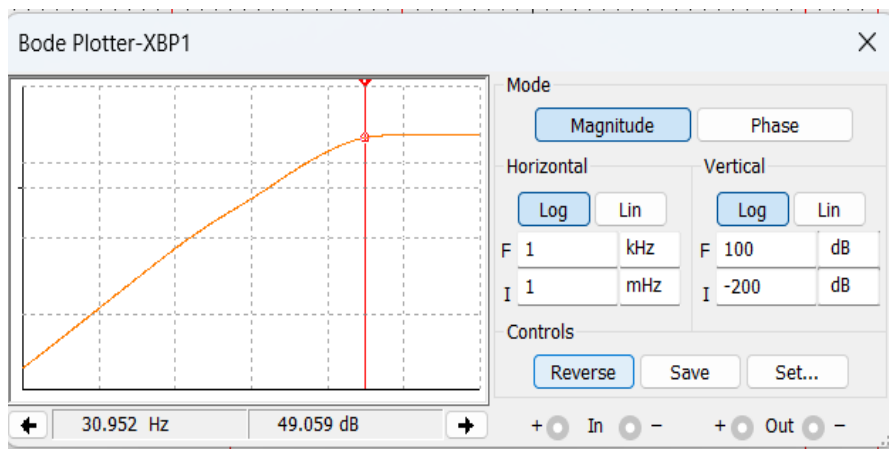
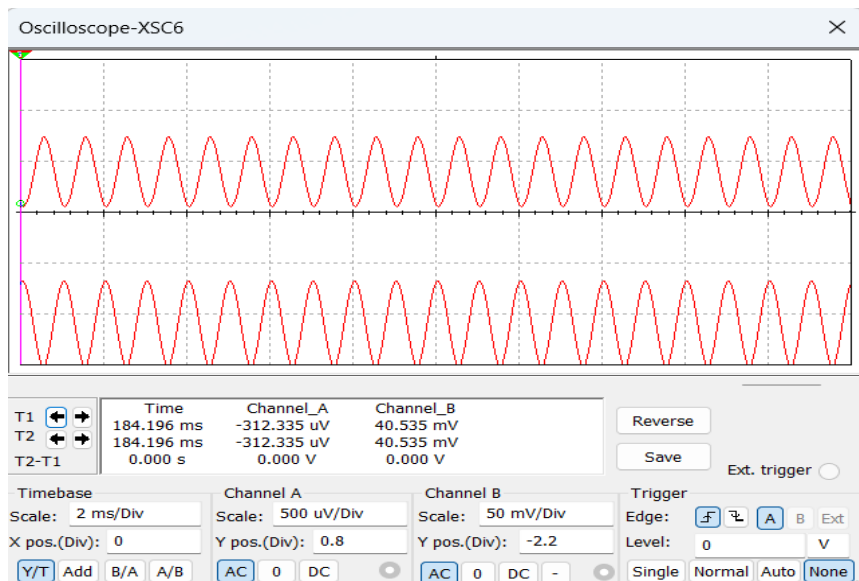
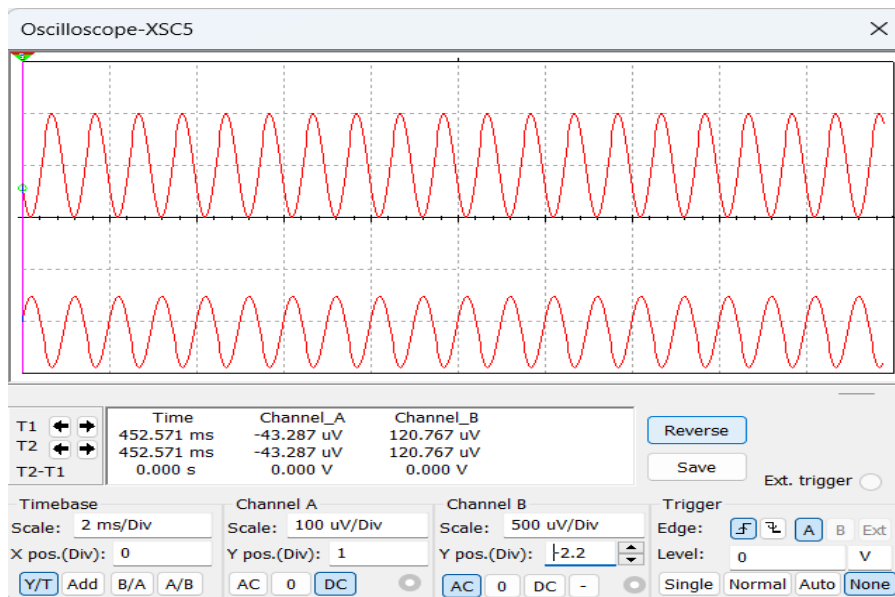
Gain of Second stage (A<sub>2</sub>) = 120

Gain of Overall circuit (A) = A<sub>1</sub>\*A<sub>2</sub> = 600

Let's reduce the feedback resistance in order to measure the gain.

### **CASE-3:** With Feedback resistance at 100K $\Omega$





When the Feedback resistance is reduced to 100K $\Omega$ , the effect on the circuit is:

Gain of first stage(A1) = 3

Gain of Second stage(A2)=125

Gain of Overall circuit(A) = A1 \* A2 = 375

When the Feedback resistance is reduced, then a maximum output signal reaches the first stage. So, the signal reaching the transistor( $V_{in1}$ ) reduces and thus the gain reduces.

$$V_{in1} = V_s - V_f$$

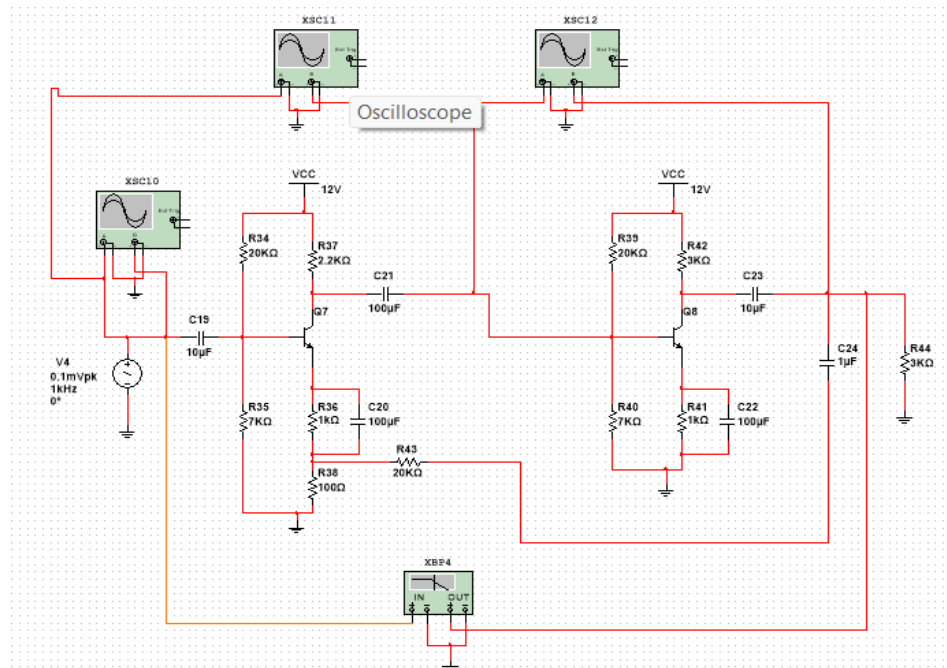
Where,  $V_{in1}$  = Input voltage to Transistor of first stage,

$V_s$  = Source Voltage,

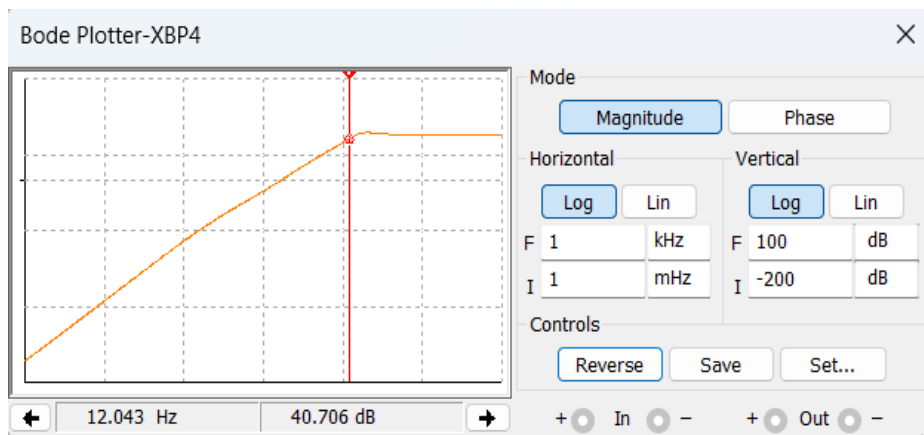
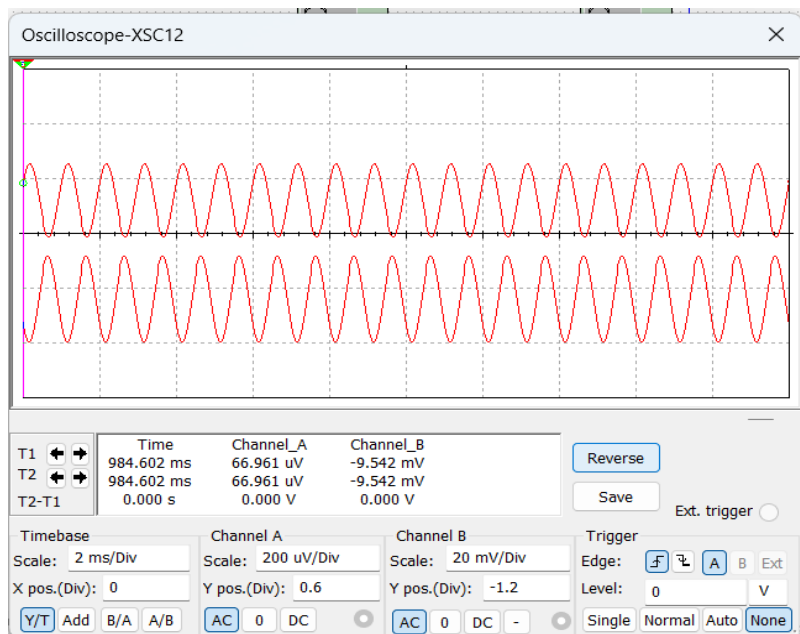
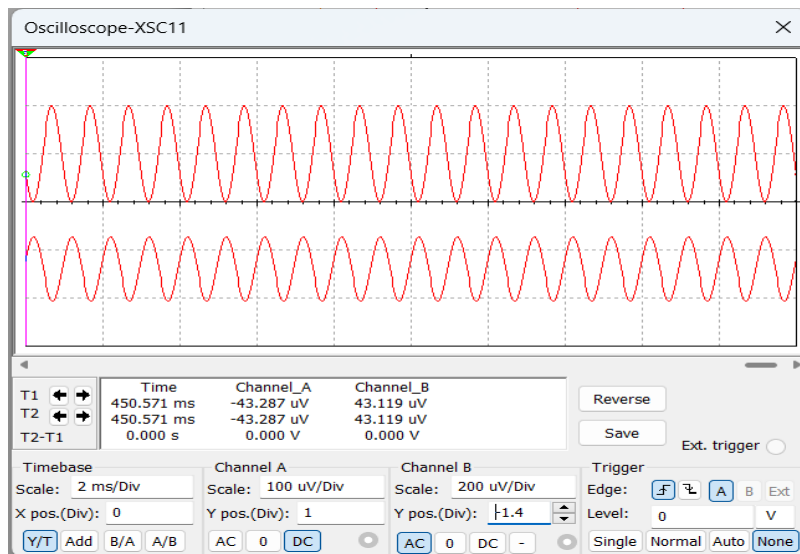
$V_f$  = Feedback Voltage.

Mid frequency gain is obtained at 52dB. So, the Cutoff frequency is at 49dB i.e.,31Hz.

#### **CASE-4:** With Feedback resistance at 20K $\Omega$







When the Feedback resistance is reduced to 20K $\Omega$ , the gain of the circuit is:

Gain of First Stage(A1) = 1.4

Gain of Second Stage(A2) = 115

Gain of Overall circuit (A) = A1 \* A2 = 161

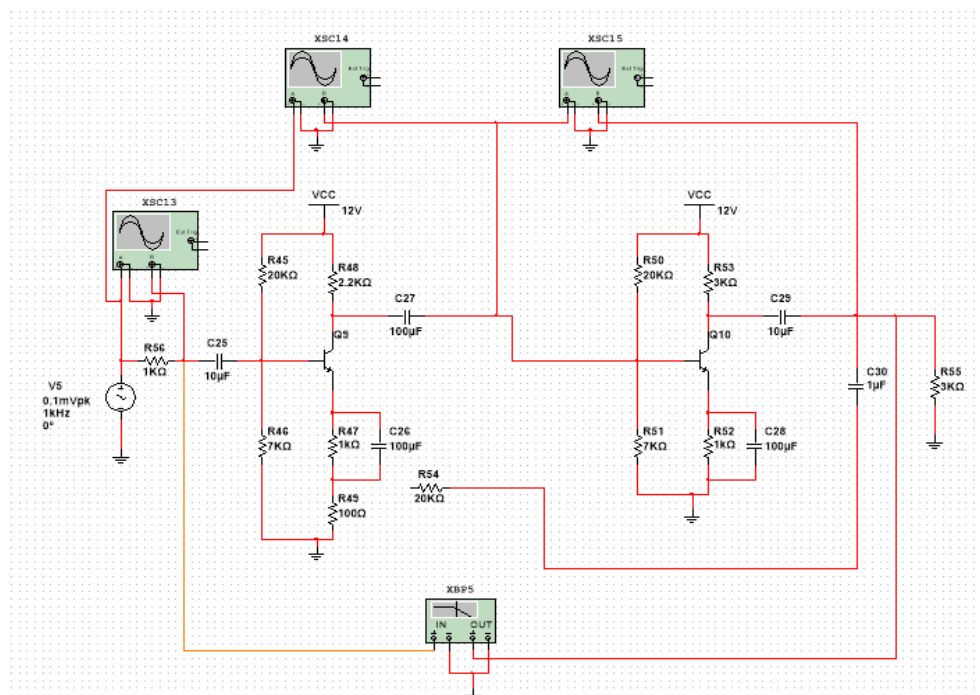
Gain is reduced compared to previous case indicating more signal voltage is getting mixed at the first stage.

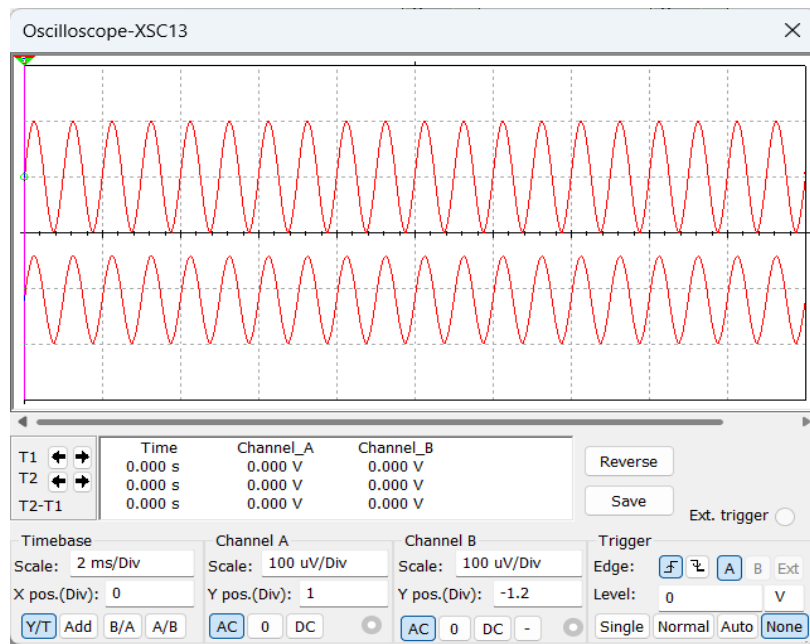
Mid frequency gain is obtained at 43dB. So, the Cutoff frequency is obtained at 40dB i.e., 12Hz.

### **Calculation of input resistance:**

In case of multistage amplifiers, the input resistance (or) source resistance should be equal to the resistance of the overall stage. If they match, maximum power can be transferred and loading effect can be reduced.

### **CASE-1:** With Input resistance at 1K $\Omega$ and without feedback

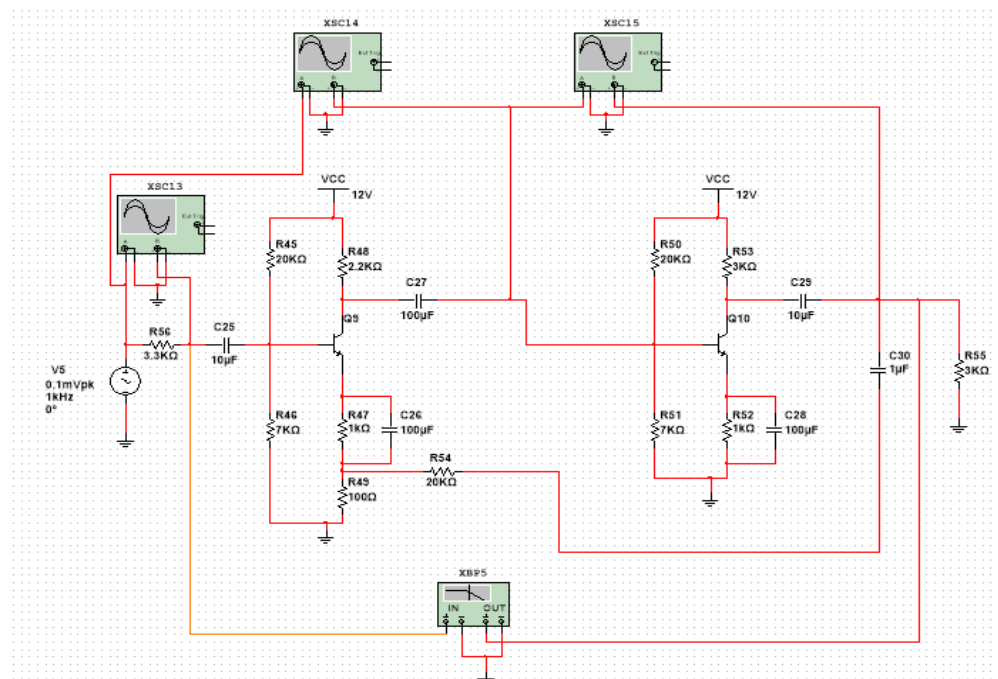


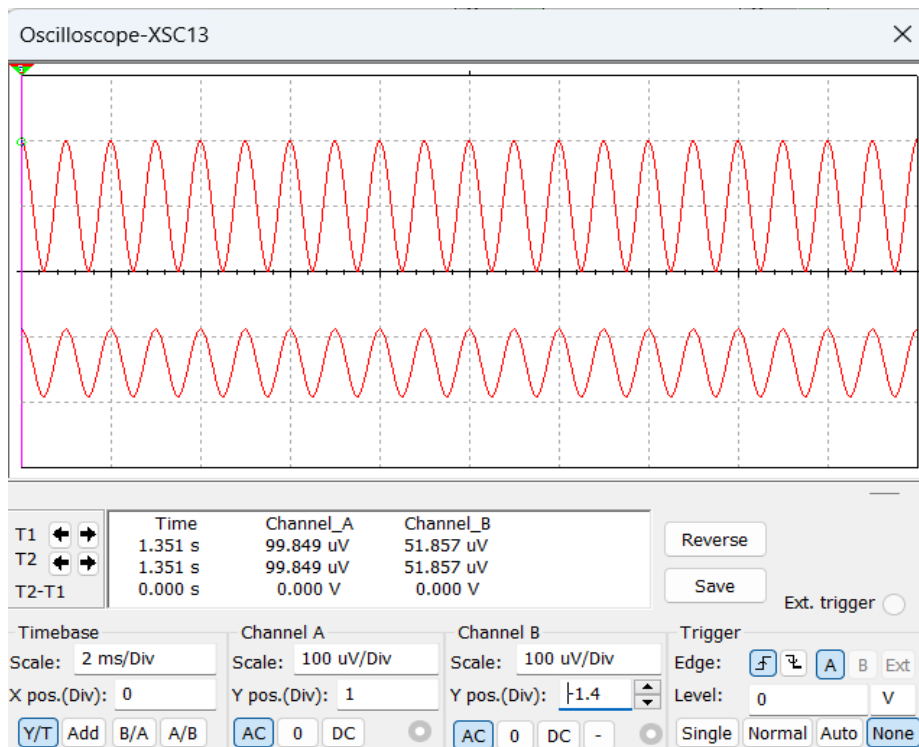


An input Voltage of  $200\mu\text{V}$  is applied at the input. In order for maximum power transfer, the voltage drop at source resistance should be exactly half of the maximum supply.

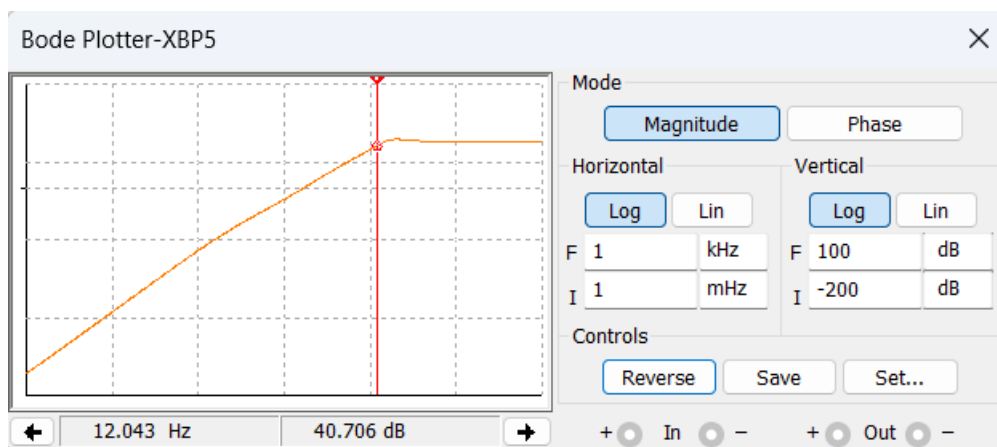
When the input (or) source resistance is at  $1\text{K}\Omega$ , voltage reaching the transistor is  $150\mu\text{V}$ , which is 75% of the input. So, the input resistance cannot be equal to  $1\text{K}\Omega$ .

## **CASE-2:** With input resistance at $3.3\text{K}\Omega$





When the input resistance is changed to  $3.3\text{k}\Omega$ , the voltage to the first transistor is exactly half of the supply. So, the input resistance for the circuit designed is  $3.3\text{k}\Omega$ .



For this Feedback amplifier with input resistance of  $3.3\text{k}\Omega$ , the mid frequency gain is obtained at 43dB. So, the Cutoff frequency is obtained at 40dB i.e., 12Hz.

**OBSERVATIONS:**

<b><u>S.No.</u></b>	<b><u>Resistance(<math>R_f</math>)</u></b>	<b><u>Input(mV)</u></b>	<b><u>Output(V)</u></b>	<b><u>Voltage Gain</u></b>
1	14k	60	7.8	130
2	45k	60	7.2	120
3	55k	60	6.6	110
4	56k	60	6.4	106
5	1M	60	4.7	78

**RESULT:**

**An increase in feedback resistance  $R_f$  the overall voltage decreases.**